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Multi-Criteria Selection and Screening for Karnal Bunt Resistance of Wheat (*Triticumaestivum* L. Em. Thell.) in Eastern Uttar Pradesh

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Sanoj Kumar [α], Shri Niwas Singh [σ], Rajesh Kumar [ρ], Baij Nath Singh [ω], Ram Lala Patel [¥] & Shashi Kant [§]

Abstract- Twenty wheat germplasm were evaluated on 14 parameters in an experiment at Center for Research and Development (CRD), Gaunar, Usaraha, Gorakhpur, U. P. in a randomized block design with three replications. The objective of the experiment was to select top five good performing genotypes on the basis of all the parameters and extent of Karnal bunt (KB) infestation. Normalized cumulative ranks were used to assess the relative performance of twenty genotypes. KOH seed soaking technique was used to assess the extent of Karnal bunt infestation. Based on normalized accumulating ranks the performance order of twenty wheat genotypes isHD3117, HPYT480, HPAW152, HD3271, HPAN196, HPYT443, HPAN165, HD3226, HPYT409, HPAN153, HPYT474, CSW18, HPYT424, HPYT489, HPYT441, HPYT490, HPYT426, HPYT418, HPAN163 and HPYT446. Four genotypes were completely resistant. Sixteen genotypes were susceptible to Karnal bunt and infestation ranged from 1.33% (HPYT-418) to 30% (HPYT-446). High performer genotypes like HD3117, HPYT480, HPAW152, HD3271, HPAN196 and Karnal bunt resistant genotypes like HPYT409, HPAN153, HPYT489 and HPYT 490 should be recommended for cultivation in this area.

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I. Introduction

Wheat is a staple food crop of majority of the people in the world. However, its production depends on availability of suitable varieties and control of diseases and pests. Plant breeders provide suitable varieties to farmers to boost food production and minimize loss incurred by pests and diseases. With the objective of providing suitable varieties to farmers we evaluated 20-wheat genotypes on 14 parameters including a test for Karnal bunt infestation. This paper presents the findings of this experiment.

II. Materials and Methods

Afield experiment was conducted in Rabi season 2019-20 at Center for Research and Development (CRD) located at Gaunar-Usaraha, Gorakhpur, Uttar Pradesh. The experimental site is located at 26°42' 45.5" N latitude, 83°36'36.6" E longitude and 86 m above mean sea level. The climate is semi-arid with hot summer and cold winter. Nearly 80% of the rainfall is received during monsoon along with a few winter showers. Twenty wheat germplasm, included in this experiment, were taken from the germplasm stock available at CRD and BRD PG College, Deoria. These genotypes were raised in a randomized block design in a timely sown condition with standard package of practices for wheat cultivation. Thus, 20 genotypes were evaluated on 14 parameters in three replications. The parameters evaluated are 1. Biological yield (abbreviated as Bio Yield), 2. 1000 seed weight, 3. Yield per hectare, 4. Days to 50% flowering, 5. Flag leaf area, 6. Karnal bunt infestation, 7. Effective tillers, 8.Spikes/m^2, 9.Spikelets/ear, 10.Ear length, 11. Peduncle length, 12.Plant height, 13.10 Ear weight and 14.Yield/Plot.

Data were collected on five randomly selected plants of all 20 genotypes and were compiled to calculate average of three replications. These were further used to calculate replication mean. These values were subjected to normalized cumulative rank (NCR) analysis as discussed by Singh and co-workers (Sanoj Kumar 2021; Singh 2017; Singh et al. 2018; Yadav et al. 2020). The idea of this analysis is based on the concept of crop ideotype as given by Donald 1968. That is why, in this analysis, we are looking for ideal plant types (=crop ideotypes) that would rank relatively high in majority of the parameters and would come first in cumulative rank or normalized cumulative rank.

III. Results and Discussion

Table 1 shows the average values of the three replications.

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Table 1: Average values of three replications

S.N.	Variety↓ Sort order→	Bio Yield	1000 seed wt	Yield/ha	Days-to-50%F	Flag Leaf Area	Karnal Bunt	Effective Tillers	Spikes/m2	Spikelets/Ear	Ear Length	Peduncle Length	Plant Ht	10 Ear Wt	Yield/Plot
		0	0	0	1	1	1	0	0	0	0	0	0	0	0
1	HD3271	28.13	40.67	26.63	84.67	49.87	3.33	5.87	570.33	20.07	9.83	47	97.97	30.67	2.13
2	HPAN153	28.93	41.67	21.04	84.67	51.93	0	6.47	420.33	18.53	9.7	50.03	99.93	26	1.68
3	HPAN163	17.47	38.67	29.83	88.67	39.37	6.33	6.07	531	17.07	9.53	45.63	99.34	23.33	2.39
4	HPAN165	23.07	45.33	25.17	86	51.26	9.67	5.73	385	19.13	10.63	53.67	111.23	28.67	2.01
5	HPAN196	19.87	43.67	26.46	86	46.7	5	5.33	517.67	20.27	10.03	47	107.83	28.67	2.12
6	HPYT409	15.87	40	27.63	84.67	48.57	0	4.2	518.33	19.87	10.01	50.3	100	28	2.21
7	HPYT418	16.8	41.67	25.46	82	52.05	1.33	4.73	402.67	18.47	10.87	51.3	98.67	24.67	2.04
8	HPYT424	23.73	41.33	30.75	87.33	49.05	11.33	5.93	497.33	18.33	9.47	50.17	99.9	25.33	2.46
9	HPYT426	23.6	44.67	27.33	87.33	57.5	11.33	6	422	17.53	9.13	45.83	100.37	30.67	2.19
10	HPYT441	18.93	38.67	23.04	86.67	42.9	3.33	5.27	520	17.87	10.17	49.7	102.2	26.67	1.84
11	HPYT443	22.67	45.33	26.75	85.33	46.27	9	6.53	427.33	18.73	10.17	52.7	101.73	22	2.14
12	HPYT446	22.13	46.33	19.33	86	35.95	30	5.6	448.33	20.13	9.48	43.03	101.23	14	1.55
13	HPYT474	19.2	43.67	30.13	86	35.84	3.33	5.2	513.67	18.53	8.67	44.13	101.73	23.33	2.41
14	HPYT480	20.13	41.67	32.08	80	55.26	11	4.33	460.33	20.87	10.87	51.07	106.87	26	2.57
15	HPYT489	18.67	37.67	16	82.67	51.51	0	5.33	507	20.53	9.67	51.73	106.8	22.67	1.28
16	HPYT490	19.73	34.33	25.54	90	50.06	0	4.8	579.67	20.27	10.53	46.6	100.3	24.67	2.04
17	HPAW152	21.33	42	26.83	84.67	50.49	5.67	4.73	552	18	10.43	53.79	108.97	29.33	2.15
18	HD3117	29.47	40.67	30.67	83.33	46.74	3	6.2	525.67	20.53	11.2	51.72	110.7	30	2.45
19	CSW18	24.27	40	17.42	89.33	59.84	3.33	5.2	446.33	22.13	11.8	48.63	112.4	32.67	1.39
20	HD3226	23.73	41.67	20.17	88.67	64.49	3.33	5.2	591.33	20.13	10.99	49.33	105.3	28.67	1.61

Table 2 shows ranks, cumulative ranks (CR) and NCR values of genotypes.

Table 2: Ranks, CR and NCR values of genotypes

S.N.	Variety↓ Sort order→	Bio Yield	1000 seed wt	Yield/ha	Days-to-50%F	Flag Leaf Area	Karnal Bunt	Effective Tillers	Spikes/m2	Spikelets/Ear	Ear Length	Peduncle Length	Plant Ht	10 Ear Wt	Yield/Plot	CR	NCR
		0	0	0	1	1	1	0	0	0	0	0	0	0	0		
1	HD3271	3	13	10	5	10	7	7	3	9	13	14	20	2	10	126	2
2	HPAN153	2	8	16	5	15	1	2	18	13	14	10	16	11	16	147	2.33
3	HPAN163	18	17	5	17	3	14	4	5	20	16	18	18	16	5	176	2.79
4	HPAN165	8	2	14	10	13	16	8	20	11	6	2	2	6	14	132	2.1
5	HPAN196	13	5	11	10	6	12	10	9	5	11	14	5	6	11	128	2.03
6	HPYT409	20	15	6	5	8	1	20	8	10	12	8	15	9	6	143	2.27
7	HPYT418	19	8	13	2	16	5	17	19	15	4	6	19	14	12	169	2.68
8	HPYT424	5	12	2	15	9	18	6	12	16	18	9	17	13	2	154	2.44
9	HPYT426	7	4	7	15	18	18	5	17	19	19	17	13	2	7	168	2.67
10	HPYT441	16	17	15	14	4	7	12	7	18	9	11	9	10	15	164	2.6
11	HPYT443	9	2	9	9	5	15	1	16	12	9	3	10	19	9	128	2.03
12	HPYT446	10	1	18	10	2	20	9	14	7	17	20	12	20	18	178	2.83
13	HPYT474	15	5	4	10	1	7	13	10	13	20	19	10	16	4	147	2.33
14	HPYT480	12	8	1	1	17	17	19	13	2	4	7	6	11	1	119	1.89
15	HPYT489	17	19	20	3	14	1	10	11	3	15	4	7	18	20	162	2.57
16	HPYT490	14	20	12	20	11	1	16	2	5	7	16	14	14	12	164	2.6
17	HPAW152	11	7	8	5	12	13	17	4	17	8	1	4	5	8	120	1.9
18	HD3117	1	13	3	4	7	6	3	6	3	2	5	3	4	3	63	1
19	CSW18	4	15	19	19	19	7	13	15	1	1	13	1	1	19	147	2.33
20	HD3226	5	8	17	17	20	7	13	1	7	3	12	8	6	17	141	2.24

On sorting the table 2, on the basis of CR or NCR in increasing order, we get table 3.

Table 3: Ranks, CR and NCR similar to table 2, but the data are sorted in increasing order based on CR or NCR

S.N.	Variety↓ Sort order→	Bio Yield	1000 seed wt	Yield/ha	Days-to-50%F	Flag Leaf Area	Karnal Bunt	Effective Tillers	Spikes/m2	Spikelets/Ear	Ear Length	Peduncle Length	Plant Ht	10 Ear Wt	Yield/Plot	CR	NCR
		0	0	0	1	1	1	0	0	0	0	0	0	0	0		
18	HD3117	1	13	3	4	7	6	3	6	3	2	5	3	4	3	63	1
14	HPYT480	12	8	1	1	17	17	19	13	2	4	7	6	11	1	119	1.89
17	HPAW152	11	7	8	5	12	13	17	4	17	8	1	4	5	8	120	1.9
1	HD3271	3	13	10	5	10	7	7	3	9	13	14	20	2	10	126	2
5	HPAN196	13	5	11	10	6	12	10	9	5	11	14	5	6	11	128	2.03
11	HPYT443	9	2	9	9	5	15	1	16	12	9	3	10	19	9	128	2.03
4	HPAN165	8	2	14	10	13	16	8	20	11	6	2	2	6	14	132	2.1
20	HD3226	5	8	17	17	20	7	13	1	7	3	12	8	6	17	141	2.24
6	HPYT409	20	15	6	5	8	1	20	8	10	12	8	15	9	6	143	2.27
2	HPAN153	2	8	16	5	15	1	2	18	13	14	10	16	11	16	147	2.33
13	HPYT474	15	5	4	10	1	7	13	10	13	20	19	10	16	4	147	2.33
19	CSW18	4	15	19	19	19	7	13	15	1	1	13	1	1	19	147	2.33
8	HPYT424	5	12	2	15	9	18	6	12	16	18	9	17	13	2	154	2.44
15	HPYT489	17	19	20	3	14	1	10	11	3	15	4	7	18	20	162	2.57
10	HPYT441	16	17	15	14	4	7	12	7	18	9	11	9	10	15	164	2.6
16	HPYT490	14	20	12	20	11	1	16	2	5	7	16	14	14	12	164	2.6
9	HPYT426	7	4	7	15	18	18	5	17	19	19	17	13	2	7	168	2.67
7	HPYT418	19	8	13	2	16	5	17	19	15	4	6	19	14	12	169	2.68
3	HPAN163	18	17	5	17	3	14	4	5	20	16	18	18	16	5	176	2.79
12	HPYT446	10	1	18	10	2	20	9	14	7	17	20	12	20	18	178	2.83

Top few accessions of table 3 could be recommended for cultivation as they might be close to ideal plant type we are looking for. From table 3, it is clear that top five genotypes *viz*., HD3117, HPYT480, HPAW152, HD3271 and HPAN196 could be recommended to farmers for cultivation in this region. Top few varieties are highly likely to replace the current standard check variety gradually. It is also clear from tables 1, 2 and 3 that only four of these varieties are completely resistant to Karnal bunt. Resistant genotypes like HPYT409, HPAN153, HPYT489 and HPYT490should be recommended for cultivation in this area. The extent of Karnal bunt infestation in susceptible varieties is ranging from 1.33% to 30%. In worst case scenario, the less infested varieties with high relative performance could be recommended for cultivation. Karnal bunt has shown its presence in this region and it should be controlled in its initial stages.

This analysis is shown step by step for the comprehension of students, but to be precise, table 1 and table 2 could be merged into a single table and again the data could be sorted in increasing order based on CR or NCR. Thus, the whole paper could be summarized in a single table as given in table 4. This is being named as precise varietal recommender system.

Table 4: Precise varietal recommender system

S.N.	Variety↓ Sort order→	Bio Yield	1000 seed wt	Yield/ha	Days-to-50%F	Flag Leaf Area	Karnal Bunt	Effective Tillers	Spikes/m2	Spikelets/Ear	Ear Length	Peduncle Length	Plant Ht	10 Ear Wt	Yield/Plot	CR	NCR
		0	0	0	1	1	1	0	0	0	0	0	0	0	0		
18	HD3117	29.47 (1)	40.67 (13)	30.67 (3)	83.33 (4)	46.74 (7)	3 (6)	6.2 (3)	525.67 (6)	20.53 (3)	11.2 (2)	51.72 (5)	110.7 (3)	30 (4)	2.45 (3)	63	1
14	HPYT480	20.13 (12)	41.67 (8)	32.08 (1)	80 (1)	55.26 (17)	11 (17)	4.33 (19)	460.33 (13)	20.87 (2)	10.87 (4)	51.07 (7)	106.87 (6)	26 (11)	2.57 (1)	119	1.89
17	HPAW152	21.33 (11)	42 (7)	26.83 (8)	84.67 (5)	50.49 (12)	5.67 (13)	4.73 (17)	552 (4)	18 (17)	10.43 (8)	53.79 (1)	108.97 (4)	29.33 (5)	2.15 (8)	120	1.9
1	HD3271	28.13 (3)	40.67 (13)	26.63 (10)	84.67 (5)	49.87 (10)	3.33 (7)	5.87 (7)	570.33 (3)	20.07 (9)	9.83 (13)	47 (14)	97.97 (20)	30.67 (2)	2.13 (10)	126	2
5	HPAN196	19.87 (13)	43.67 (5)	26.46 (11)	86 (10)	46.7 (6)	5 (12)	5.33 (10)	517.67 (9)	20.27 (5)	10.03 (11)	47 (14)	107.83 (5)	28.67 (6)	2.12 (11)	128	2.03
11	HPYT443	22.67 (9)	45.33 (2)	26.75 (9)	85.33 (9)	46.27 (5)	9 (15)	6.53 (1)	427.33 (16)	18.73 (12)	10.17 (9)	52.7 (3)	101.73 (10)	22 (19)	2.14 (9)	128	2.03
4	HPAN165	23.07 (8)	45.33 (2)	25.17 (14)	86 (10)	51.26 (13)	9.67 (16)	5.73 (8)	385 (20)	19.13 (11)	10.63 (6)	53.67 (2)	111.23 (2)	28.67 (6)	2.01 (14)	132	2.1
20	HD3226	23.73 (5)	41.67 (8)	20.17 (17)	88.67 (17)	64.49 (20)	3.33 (7)	5.2 (13)	591.33 (1)	20.13 (7)	10.99 (3)	49.33 (12)	105.3 (8)	28.67 (6)	1.61 (17)	141	2.24
6	HPYT409	15.87 (20)	40 (15)	27.63 (6)	84.67 (5)	48.57 (8)	0 (1)	4.2 (20)	518.33 (8)	19.87 (10)	10.01 (12)	50.3 (8)	100 (15)	28 (9)	2.21 (6)	143	2.27
2	HPAN153	28.93 (2)	41.67 (8)	21.04 (16)	84.67 (5)	51.93 (15)	0 (1)	6.47 (2)	420.33 (18)	18.53 (13)	9.7 (14)	50.03 (10)	99.93 (16)	26 (11)	1.68 (16)	147	2.33
13	HPYT474	19.2 (15)	43.67 (5)	30.13 (4)	86 (10)	35.84 (1)	3.33 (7)	5.2 (13)	513.67 (10)	18.53 (13)	8.67 (20)	44.13 (19)	101.73 (10)	23.33 (16)	2.41 (4)	147	2.33
19	CSW18	24.27 (4)	40 (15)	17.42 (19)	89.33 (19)	59.84 (19)	3.33 (7)	5.2 (13)	446.33 (15)	22.13 (1)	11.8 (1)	48.63 (13)	112.4 (1)	32.67 (1)	1.39 (19)	147	2.33
8	HPYT424	23.73 (5)	41.33 (12)	30.75 (2)	87.33 (15)	49.05 (9)	11.33 (18)	5.93 (6)	497.33 (12)	18.33 (16)	9.47 (18)	50.17 (9)	99.9 (17)	25.33 (13)	2.46 (2)	154	2.44
15	HPYT489	18.67 (17)	37.67 (19)	16 (20)	82.67 (3)	51.51 (14)	0 (1)	5.33 (10)	507 (11)	20.53 (3)	9.67 (15)	51.73 (4)	106.8 (7)	22.67 (18)	1.28 (20)	162	2.57
10	HPYT441	18.93 (16)	38.67 (17)	23.04 (15)	86.67 (14)	42.9 (4)	3.33 (7)	5.27 (12)	520 (7)	17.87 (18)	10.17 (9)	49.7 (11)	102.2 (9)	26.67 (10)	1.84 (15)	164	2.6
16	HPYT490	19.73 (14)	34.33 (20)	25.54 (12)	90 (20)	50.06 (11)	0 (1)	4.8 (16)	579.67 (2)	20.27 (5)	10.53 (7)	46.6 (16)	100.3 (14)	24.67 (14)	2.04 (12)	164	2.6
9	HPYT426	23.6 (7)	44.67 (4)	27.33 (7)	87.33 (15)	57.5 (18)	11.33 (18)	6 (5)	422 (17)	17.53 (19)	9.13 (19)	45.83 (17)	100.37 (13)	30.67 (2)	2.19 (7)	168	2.67
7	HPYT418	16.8 (19)	41.67 (8)	25.46 (13)	82 (2)	52.05 (16)	1.33 (5)	4.73 (17)	402.67 (19)	18.47 (15)	10.87 (4)	51.3 (6)	98.67 (19)	24.67 (14)	2.04 (12)	169	2.68
3	HPAN163	17.47 (18)	38.67 (17)	29.83 (5)	88.67 (17)	39.37 (3)	6.33 (14)	6.07 (4)	531 (5)	17.07 (20)	9.53 (16)	45.63 (18)	99.34 (18)	23.33 (16)	2.39 (5)	176	2.79
12	HPYT446	22.13 (10)	46.33 (1)	19.33 (18)	86 (10)	35.95 (2)	30 (20)	5.6 (9)	448.33 (14)	20.13 (7)	9.48 (17)	43.03 (20)	101.23 (12)	14 (20)	1.55 (18)	178	2.83

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